REMARKS

No amendments to the claims have been made in this response.

Amendments to the paragraph starting at page 3, line 1, correct some minor inaccuracies in the description of the prior art. The amendments do not alter the relevance of the prior art or materially alter the originally filed description of prior art.

Rejections Under 35 USC §103

Applicants respectfully traverse the rejections.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all of the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed.Cir. 1991). MPEP 2142 and MPEP 2143 - 2143.03.

The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. MPEP, § 2143.01, citing *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990).

Also, if a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. MPEP 2143.01, citing *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984).

Furthermore, if the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious.

MPEP 2143.01, citing *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1951).

"Obvious to try" is not the standard of 35 USC 103; that is, it is not obvious to try varying every parameter or try every possible combination. *In re Geiger*, 2 USPQ 2d 1276, 1278 (Fed. Cir. 1987); *In re Yates*, 211 USPQ 1149, 1151 (CCPA 1981); *In re Antonie*, 195 USPQ 6, 8 (CCPA 1977).

Proceeding contrary to accepted wisdom in the art is evidence of nonobviousness. MPEP § 2145, X. D. 3., citing *In re Hedges*, 783 F.2d 1038, 228 USPQ 685 (Fed. Cir. 1986).

As explained below, applicants believe there are no *prima facie* cases of obviousness under 35 USC 103(a). There is no suggestion or motivation in the cited references or in the prior art in general to combine the references as suggested by the Examiner, and there is no expectation of success. Finally, the combinations of references suggested by the Examiner do not show or suggest all of the claim limitations, particularly of independent claims 1, 14, 37 and 41.

Claims 1 – 4, 10 – 11, 14 – 18, 33, 34 and 41 were rejected under 35 USC 103(a) as being unpatentable over Agarwal et al., U.S. Patent No. 6,365,486, issued April 2, 2002 (hereinafter "Agarwal et al") in view of Huang et al., U.S. Patent No. 6,146,941, issued November 14, 2000 (hereinafter "Huang et al).

Applicants respectfully traverse.

All of independent claims 1, 14, 37 and 41 include the limitation of depositing ruthenium on a substrate. Independent claim 1 essentially claims: providing an iodine-containing precursor gas; generating a plasma to create excited iodine species; exposing a dielectric layer to the excited iodine species to form a plasma-treated dielectric layer; and then depositing a ruthenium thin-film on the plasma-treated layer using CVD. Independent claim 14 has similar limitations except the precursor may include lead, tin, gallium or indium in addition to or instead of iodine, and ruthenium is deposited on a substrate surface that is not necessarily dielectric. Independent claim 37 is similar to independent claim 14 except that it includes an additional limitation of depositing a second metal layer

on the deposited ruthenium thin film. Independent claim 41 includes substantially the same limitations as Independent claim 14, but independent claim 41 is used expressly for slowing the deposition of ruthenium on a substrate.

Applicants believe that the Examiner's statements about the teachings of Agarwal et al. are not accurate. Agarwal et al. do not teach providing an iodine-containing precursor gas or surfactant species. Agarwal et al. do not teach generating a plasma discharge to create excited iodine species from an iodine-containing precursor gas. Agarwal et al. do not teach exposing a dielectric layer or other substrate to excited iodine species.

At col.4, lines 57 -- 63, Agarwal et al. teach a reactive atmosphere that can be composed of various gaseous materials, but the list of materials does not include an iodine-containing species.

At column 5, lines one -- 3, Agarwal et al. teach that exposure of the dielectric layer to the reactive environment "*converts the top few monolayers of dielectric layer 16 into passivation layer 18a*" [italics added]. In the same paragraph, at column 5, lines 13 -- 23, Agarwal et al. teach various general formulas for the chemical composition of the formed passivation layer, which may include iodine. Thus, while Agarwal et al. do not expressly teach the origin of the iodine in the passivation layer, they imply that iodine may be present in the dielectric layer that is "converted" to the passivation layer.

Therefore, Agarwal et al. do not teach generating a plasma discharge to create excited iodine species from an iodine-containing precursor gas and exposing a dielectric layer or other substrate to excited iodine species.

The undersigned Applicants' attorney was not able to find any teaching by Agarwal et al. regarding the pressure at which a dielectric layer is exposed to a "reactive atmosphere".

Agarwal et al. teach formation in a reactive atmosphere of a passivation layer having a finite thickness that serves as a protective diffusion barrier to protect an electrode against oxidation and to prevent the transport of oxygen, carbon and other species between a dielectric layer and an electrode. Agarwal et al., col. 6, lines 17—24; col. 8, lines 2—6. In contrast, the present invention does not teach formation of a layer having a finite thickness

during plasma treatment. Declaration of Sanjay Gopinath, ¶ 6 (hereinafter "Gopinath Declaration"). In fact, formation of a passivation layer having a finite thickness by converting the underlying substrate to a diffusion barrier as in Agarwal et al. would render the present invention useless because it would unacceptably alter the dielectric constant and other electronic properties of substrate layers surrounding metallization layers. Gopinath Declaration, ¶ 7. Conversely, if the teaching of Agarwal et al. were modified to make a plasma-treated substrate as in the present invention, then the resulting plasma-treated substrate would not be useful as a protective passivation layer as in Agarwal et al. Gopinath Declaration, ¶ 8. This is because a plasma-treated surface in accordance with the present invention does not provide a protective passivation layer between a starting substrate (e.g., the dielectric of Agarwal et al.) and the ruthenium thin-film deposited on the substrate. Gopinath Declaration, ¶ 8. If a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. MPEP 2143.01, citing *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984).

A principle of operation of the passivation layer of Agarwal et al. is formation of a passivation layer having a finite thickness that serves to prevent diffusion, chemical interaction and any physical contact between a dielectric layer and an adjacent metal electrode layer. Gopinath Declaration, ¶ 9. In contrast, the principle of operation of the present invention is plasma treatment of a dielectric layer (or other substrate layer) to promote in a desirable way the physical contact and chemical interaction between the dielectric layer (or other substrate) and the metal (i.e., ruthenium) deposited on it. Gopinath Declaration, ¶ 10. In other words, the principle of operation of Agarwal et al. is no contact and no interaction, whereas the principle of operation of the present invention is enhanced physical contact and a desired interaction and reaction (i.e., enhanced nucleation of ruthenium metal on the substrate and slowed deposition rate). Gopinath Declaration, ¶ 11. These principles of operation are mutually exclusive, so that a method in accordance with the present invention is inconsistent with the principle of operation of Agarwal et al. Gopinath Declaration, ¶ 11. If the proposed modification or combination of

the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. MPEP 2143.01, citing *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1951).

Although Agarwal et al. mentions that the nature of the reactive gaseous environment can be altered or enhanced if desired by using any type of plasma source, Agarwal et al. do not teach any of the operating conditions or any details regarding their use of plasma. Gopinath Declaration, ¶ 12. As a result, one skilled in the art would have to conduct many experiments to find plasma conditions for enhancing a reactive gaseous environment in a method of Agarwal et al. Gopinath Declaration, ¶ 12. "Obvious to try" is not the standard of 35 USC 103; that is, it is not obvious to try varying every parameter or try every possible combination. *In re Geiger*, 2 USPQ 2d 1276, 1278 (Fed. Cir. 1987); *In re Yates*, 211 USPQ 1149, 1151 (CCPA 1981); *In re Antonie*, 195 USPQ 6, 8 (CCPA 1977).

For the reasons explained above, Applicants also believe that the combination of Agarwal et al. with Huang does not teach important claim limitations of the present invention (generating a plasma discharge to create excited iodine species from an iodine-containing precursor gas and exposing a dielectric layer or other substrate to excited iodine species), and that the combination modified as suggested by the Examiner would render the combination unsatisfactory for its intended purpose and would change its principle of operation.

Claims 6, 7, 12, 20 – 22, and 35 were rejected under 35 USC 103(a) as being unpatentable over Agarwal et al. et al., U.S. Patent No. 6,365,486, in view of Pyo et al., U.S. Patent No. 6,593,236, issued July 15, 2003 (hereinafter "Pyo et al").

Applicants respectfully traverse.

As explained above, Agarwal et al. do not teach generating a plasma discharge to create excited iodine species from an iodine-containing precursor gas and exposing a dielectric layer or other substrate to excited iodine species. Instead, Agarwal et al. merely teach converting a dielectric layer to a passivation layer that may contain iodine. Pyo et al.

teach formation of a chemical enhancer layer from an iodine-containing compound without mentioning use of plasma. Pyo et al., col. 2, lines 41—52. Therefore, there is no suggestion in the references or in the art to combine Agarwal et al. with an iodine-containing compound of Pyo et al. to make excited iodine species. Gopinath Declaration, ¶ 13. Furthermore, Pyo et al. teach formation of a chemical enhancer layer to speed up the MOCVD deposition rate of copper onto a copper seed layer. Thus, the purpose of the invention of Pyo et al. is completely unrelated to the purpose of Agarwal et al. Therefore, there is no suggestion in the references or in the art of an expectation of success or of the desirability of using an iodine-containing compound of Pyo et al. in a reactive atmosphere of Agarwal et al. Gopinath Declaration, ¶ 14. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed.Cir. 1991). MPEP 2142 and MPEP 2143 - 2143.03. The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. MPEP, § 2143.01, citing *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990).

A method in accordance with the present invention treats a substrate with excited iodine species to improve deposition of a ruthenium thin film by decreasing the nucleation delay of ruthenium growth on a plasma-treated substrate and also by decreasing the deposition rate of ruthenium onto a plasma-treated substrate. In contrast, Pyo et al. teach that a chemical enhancer layer formed using an iodine-containing compound of Pyo et al. actually accelerates the deposition speed of copper. Pyo et al., col. 1, lines 41—42. Therefore, the use of an iodine-containing precursor in the present invention to plasma-treat a substrate, resulting in decreased deposition rate of ruthenium, was contrary to the accepted wisdom in the art of using an iodine compound to increase the speed of metal deposition. Gopinath Declaration, ¶ 15. Proceeding contrary to accepted wisdom in the art is evidence of nonobviousness. MPEP § 2145, X. D. 3., citing *In re Hedges*, 783 F.2d 1038, 228 USPQ 685 (Fed. Cir. 1986).

For the reasons explained above and since claims depending from allowable claims

are also allowable, it is believed that claims 1 – 41 are in condition for allowance and their reconsideration and allowance is respectfully requested.

Respectfully submitted,

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